

Riparian Age Forest Structure and Past Hydroclimate

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PROJECT SUMMARY

Introduction and Background

On November 29, 1864, soldiers from the US military attacked a peaceful encampment of Cheyenne and Arapaho along Big Sandy Creek in southeastern Colorado. Over 150 Indians were killed in the attack, most of whom were women, children, or elderly. The massacre profoundly influenced US-Indian relations and the structure of the Cheyenne and Arapaho tribes. Sand Creek Massacre National Historic Site was established in 2007 to preserve and protect the cultural landscape of the massacre, enhance public understanding, and minimize the chance of similar incidents in the future.

The riparian cottonwood forests of the Sand Creek Massacre site are important elements of the cultural landscape and riparian ecosystem, providing shelter, timber, firewood, forage, and wildlife habitat. Plains cottonwood trees (*Populus deltoids* ssp. *monilifera*) along Big Sandy Creek, living and dead, have cultural and spiritual significance because of their association with the Cheyenne and Arapaho encampments and the massacre. To preserve the cultural landscape the site as closely as reasonable to its appearance at the time of the massacre, a dendrochronological, or tree-ring dating, analysis of riparian cottonwood stands was conducted to identify trees that may have been alive at the time of the massacre.

The study described the overall age and spatial structure of the stands and attempted to link the patterns of tree establishment with hydroclimatic factors, such as floods or drought, which may have influenced development of cottonwood stands. Cores were mounted and sanded, and cross-dated to establish exact calendar years for each growth ring. This study contributes to the understanding of the site's environmental history, current conditions, changes that have occurred over time, and possible causes of those changes.

Establishment of Cottonwoods

By comparing aerial photographs from 1937 with recent photos, researchers identified living trees at least 75 years old. The comparison clearly shows a large increase in trees since the



NPS

A researcher extracts a core from a cottonwood tree.

1930s which form dense and scattered sections of gallery forest along the current stream channel. The oldest cottonwoods appeared to be separated in linear clusters of 1-30 trees. The study identified 49 “old” trees for sampling, 4 of which were dead. Younger trees were sampled in transects perpendicular to the channel. Trees were measured for diameter at breast height (dbh). Cores were collected from “old” living trees that were not hollow or rotten and were mounted, surfaced, and cross-dated. Ring-width was measured for several cores to create a master chronology to confirm the cross-dating and examination of the climate response of trees.

Results and discussion

While no trees were conclusively dated to 1864, the collective evidence suggests that multiple trees were alive as seedlings or saplings at the time of the massacre. Older trees sampled were generally very large in diameter and often had large, deep furrows in the bark, gnarled limbs, and asymmetrical crowns. Most of the sampled trees had significant rotting or were partly hollow; only nine cores extended close enough to the center of the tree to reliably estimate the date from the curvature of the inner rings.

Estimated germination dates revealed three distinct age classes of trees (1865-1885, 1908-1925, and 1949-1960) compose the main gallery. Of the trees sampled, three had estimated germination dates between 1865 and 1870. Ages of trees in the youngest age class (1949-1960) dramatically confirmed even-

aged stands of trees with peaks in age distribution in 1949 and 1954. Of the 116 trees sampled, only one tree was estimated to be less than 40 years old. No seedlings or saplings were observed and there appears to be virtually no cottonwood establishment since 1965.

The current channel is lined by a forest established in the 1960s, which suggests no change in location since that time. The locations of older trees can be used to reconstruct the changes in the active Big Sandy Creek channel and its location in 1864.

Hydroclimatic Context of Ecosystem Change

A literature and data search was conducted to link the riparian forest ecosystem changes, such as the peaks of tree establishment, with events in the hydroclimatic records. Research focused on the ecology of Plains cottonwoods, climate, and flood events in southeastern Colorado. The colonization of three age classes of cottonwoods along the creek bed after 1864 may be associated with flooding events and is consistent with the prevailing flood-driven model of cottonwood establishment in western North America. Flooding removes competing vegetation, deposits of fresh sediment as seedbed, and temporary elevates the water table. Trees established by these periodic episodes tend to occur along stream channels.

The hydroclimatic environment during cottonwood establishment was constructed by examining precipitation, temperature, and streamflow datasets for southeastern Colorado between 1893 and 2005. Regional climate was also reconstructed based on tree-ring data.

Results and conclusions

The patterns of tree establishment (e.g., discrete age classes and clusters) fit the flood-driven with the prevailing flood-driven model of cottonwood establishment in western North America. Tree growth tends to be favored by wetter and cooler conditions during the growing season, though this does not appear to be a precondition for establishment. Initiation dates of the three age classes coincide with probable flood events on Big Sandy Creek, inferred from historical, meteorological, and hydrologic data.

It is possible storms in southeastern Colorado during May or June 1864 caused floods on Big Sandy Creek around the same time. Similar widespread flooding across eastern Colorado also occurred in June 1865. Climate and streamflow data since 1893 also support the establishment of cottonwoods driven mainly by infrequent, large floods. Daily precipitation data and records of peak flow suggest major flood events affecting Big Sandy Creek in at least 1908. Though there are



The current channel of Big Sandy Creek is lined by a cottonwood forest established in the 1960s.

no historical records of flooding in Big Sandy Creek around 1908 an intense rainfall event occurred in October 1908 in southeast Colorado which caused severe flooding on Arkansas River. The establishment of the 1910-1925 cluster may also related to the nearby construction of the Chivington-Brandon Irrigation Canal.

The large variability in levels of recruitment into the stands over time is likely driven by natural periodic flooding. Very little establishment of cottonwoods has occurred since 1965, which is typical of natural fluctuations in similar riparian ecosystems. However, land use may be a contributing factor. Records of peak flows of Big Sandy Creek are too short and sparse to determine whether a decline related to land use changes occurred. Establishment may have been more directly impacted in the past several decades by heavy grazing, trampling, or mowing.

Literature Cited

Lukas, J. and C. Woodhouse. 2006. Riparian forest age structure and past hydroclimatic variability, Sand Creek Massacre National Historic Site. Final report. Boulder, CO: University of Colorado at Boulder, Institute of Arctic and Alpine Research (INSTAAR).

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